Study of Micro Climatic Zones of Jharkhand Since 1980

Pre-Registration Seminar for Ph.D. in Geography

(Faculty of Social Science)

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1. Brief Introduction of the Research Topic

Formation of Jharkhand as a new state has led to rapid rate of socio-economic and political development across all the districts of Jharkhand. Since then, rapid rate of urbanisation and modification of natural landscape can be seen everywhere within the state. Development of industries, factories, business centres, hospitals and educational institutions, roads and other infrastructures are constructed for the betterment of people of Jharkhand. These developments are a necessity but with development and modification of natural landscape, a change in weather and climate over time can be observed which is not sustainable for the health, well-being, and longevity of people of Jharkhand.

"Earlier in 1960s-1970s people of Jharkhand, then part of Bihar, enjoyed all time good and pleasant climate." (Munda, M.S. & Ranjan, R.K. 2022). "In 1960s and 1970s people of Jharkhand enjoyed very good climate, Ranchi was the summer capital of undivided Bihar. But now the temperature rises to 40˚C in April and May." (Singh, S.K. 2020). Different textbooks describe Jharkhand for having cool and pleasant climate throughout the year. But since the establishment of Jharkhand as a new state, development and urbanisation is seen at a rapid rate. Deforestation and disappearance of surface water bodies due to construction has resulted in change of weather and climate throughout the state. All 24 districts of Jharkhand are drought prone. In last 14 years, state has experienced a situation of drought seven times. And there is a decline in rainfall tendency since the formation of Jharkhand. "According to World Climate Data, Jharkhand may experience an increase of 2˚C - 3 ˚C in summer and temperature of 4.78 ˚C-5.2 ˚C in winter during 2020-2050" (Ranjan, M. 2023). We can see that Jharkhand is also getting affected by climate change, but many are still unaware of it.

Ranchi once a small town with pleasant climate and forest and water bodies all around changed to the state capital with remarkable changes in terms of natural and infrastructural landscapes, leading to urban sprawl. Impulse of development after new state formation has also been seen all over the state. The need for rapid infrastructural demands, the landscape of the state has drastically changed in the last 35-40 years, which has affected the weather, and a climatic variation can be observed and felt. Different parts of the region have changed land use land cover, with some areas having considerably good amount of tree cover, some have abundant surface water bodies whereas some have clusters of concrete buildings and concrete jungles. These factors play an important factor in developing a distinctive type of microclimate in their

particular type of land cover in a region. Urban Heat Island (UHI) and thermal severity can be felt in the urban areas and areas with less vegetation cover of the districts, respectively.

According to Encyclopaedia of Atmospheric Sciences, 2003, 'Microclimate is the condition of atmosphere in the layers horizontally affected directly by the characters of underlying surface. A microclimate is a collection of environmental factors that are monitored in specific locations close to the surface of the planet having a unique weather in terms of temperature, precipitation, air quality and other parameters.

The proposed research, "Study of Micro Climatic Zones of Jharkhand Since 1980" with Special Reference to Temperature and Precipitation, focus on study micro climatic zones of Jharkhand which will include the climatic study based on physical divisions. The study will be on temperature and precipitation as base for identification of micro climatic zones and use land use land cover change to establish a relation between underline factors and particular type of weather. The study will compare the climate of Jharkhand of last 35-40 years to identify the climate change to the present and as use land use land cover to relate to its type of micro climatic zones caused by it. Apart from this, the research will deal with a comparative study of global climatic change pattern with respect to the Jharkhand and determine prospects of the study area and it will also deal with measures and policies for climatic change.

2. State of Art

"The climate change is defined as variations and shifts in weather conditions over space and time of different scales and magnitude resulting into change of climate type" (Singh, S. 2012). The identification of variations in weather and its seasonal shift with time of any given area along with identification of the scale and intensity of changes in the elements of weather can help identify the climate change of any region. "Regional climatology is studied in three ways, on the basis of spatial scales, macro, meso and micro" (Singh, S. 2011). Thus, for studying climatic research at regional or local level, one can opt any of the mentioned scales for the regional studies. Microclimate is an important scale for studying climatic research as there are lot of research conducted at international level but at local or regional level in India research on climate are few. Apart from this, there are limited number of researchers in the field of climatology at state level, especially Jharkhand.

“It is well established that urban microclimates generally differ from those of nearby non-urban areas. The surface energy characteristics of urban areas possess unique properties like desert locations. The study of ‘urban heat island’ and other specific environment effects related to cities is an important topic for physical geographers” (Husain, M. 2012). As suggested, research studies in the field of urban heat island and urban climate are needed, as a large proportion of people reside in urban areas, the changing climate will greatly affect many people.

“The climate of an urban area denotes the example of modified climate by human activities. The process of urbanisation changes the radiation and heat balance at local level which becomes regional in character when the effects are extended to larger areas. The modified urban climate at local level generates different sets of local climates which have far reaching effects on patterns of horizontal and vertical air circulation, air pollution, surface runoff and modification of hydrological characteristics and increase of floods and formation of urban heat islands” (Singh, 2012). The impact of human activities on climate, radiation and heat balance of any area, urbanisation and its effect on weather and climate of surrounding areas, urban climate and urban heat island are some of the important attributes to be researched.

“Nature of land and water bodies play an important role in maintaining temperature of a particular place. Nature of ground surface in terms of colour, vegetation, land use pattern practices etc. effects the distribution of temperature” (Husain, M. 2011). “The forest plays a vital role in maintaining the oxygen and carbon balance of the earth. Forest destruction changes surface and air temperature, moisture content and reflectivity” (Husain, M. 2012). At micro level, the major factors that affects the temperature or weather need to be studied as to identify the factors that contribute to temperature rise and factors that regulate temperature. “As surface water evaporates, substantial energy is absorbed, resulting in a lowering of nearby air temperature. The land containing far less water, experience far less evaporation and therefore is moderated less by evaporative cooling” (Husain, 2012). The study of landforms and evaporation and extend to which it affects the weather and climate of any area, variations and its changes are also to be researched. “Highlands are always colder than surrounding lowland. Global warming is mainly because of human activities” (Husain, 2012). Majority of districts in Jharkhand are highland or plateaus and are largely affected by climate change. Now at present whole of Jharkhand experience hot climate for eight to nine months a year except in winter. So, the changing climate and its factors are to be researched at micro level. “There is a definite difference in temperature between forested region and open ground. During the day, tree lose

water by evapotranspiration so that the air above is cooled" (Leong, 2015). So, the land cover and land use pattern need to be studied as to find relation between changing weather and land use and to find measures for climate change and rising temperature.

"Due to climate change, drought, floods, global warming, change in patterns of precipitation, desertification, increase in tropical cyclones, cloud cover will be seen" (Khullar, 2012). "The warming of the state and climate change have increased drought, heat waves etc. climate change has undoubtedly changed but human beings are responsible" (Singh kr. Sunil). Since the formation of Jharkhand, urbanisation and development is rapidly increased and the outcome is seen in the climate of Jharkhand, and we are responsible for it. "Human societies will be seriously affected by extremes in climate and rainfall leading to droughts and floods. A changing climate would bring about alteration in the frequency and intensity of these extreme weather events. This is also a fundamental concern for human health and wellbeing" (Bharucha, E. 2021). We need to take climate change and global warming seriously as it is largely affecting the people's health and wellbeing and this change in climate is further leading to more changes in different phenomenon of weather and climate. "According to a large majority of the international scientific community, rising temperature will lead to great change in global ecosystems, human health, activities and efficiency and distribution of human population" (Husain, M. 2013). "The impact of deforestation on the environment can be seen in the form of microclimate changes, increase in temperature, decrease in rainfall, increase in frequency of floods and droughts etc. Urbanisation effects the local climate through formation of urban heat island, creation of pollution dome above the city and alteration of urban hydrological region etc" (Gautam, A. 2009). "Environment degradation such as air and water quality, uglification of landscape is serious world-wide phenomenon found in either urban centre also faces problems of urban heat island where temperature is degrees above the surrounding countryside" (Siddhartha & Mukherjee, 2012). Jharkhand has seen deforestation in large number, due to which rise in temperature, decrease in rainfall, drought can be seen since last few decades. "Increase in urbanisation, covering bare ground by pucca structures, changing thermal properties of ground surface, reduces albedo, lower the speed of arial, increase mean annual temperature and create urban heat island" (Singh, S. 2012). "Any changes in natural state of heat balance may change weather and climatic conditions from local through regional to global level which in terms would affect the hydrological cycle and processes" (Singh Savindra, 2014). Thus, studying the land use and land cover at local level is very important as it affects not only local but regional and global weather and climate as well.

"Man as a modifier of physical environment and creator of cultural environment is a cultural man who plays an active role in transforming the landscape. He contributes this share in changing the physiognomy of the earth. But some changes are threatening efforts for sustainable development, causing climate change and global warming" (Singh R.L., 2017). "In most arid regions of the world, the rains are very unpredictable. It is an unpredictable climatic condition and occurs due to the failure of one or more monsoon. While it is not possible to prevent the monsoon from failure, good environment management can reduce the ill effects of water scarcity" (Bharucha, 2021). Human beings are responsible for majority of changes around itself in the environment and these changes has resulted to threatening of sustainability and longevity but with proper environment and climate management, climatic change can be controlled, or impact can be minimised and reduced.

"The conventional methods of data collection and analysis discussed so far are too costly, time consuming, less reliable and suffer from many other eliminations. Modern technologies like the remote sensing, global positioning system, geographical information system etc, fortunately strike at their very shortcoming of the traditional methods. These technologies offer quick building of the data base which are far more reliable and that rationalises the decision-making process" (Chandna, 2009). Thus, there should be mixture of study which includes both, the traditional method of data collection as well as using advance methods of data collection and analysis for better understanding and clarity.

At present, climate change is one of the most concerned issues not only for geographers but also for other researchers of various disciplines, as climate change has affected each and every aspect of human life and environment causing a great threat not only to present generations but also for the sustainability of coming generations. Climate change has become a major issue at global level to such an extent that Inter-Governmental Conferences and summit are held, and Climate change and sustainable development is one of the main issues of the conference. Thus, research in the field of climatology at micro level is needed as to identify the changes that are observed at local level and the reasons for those changes and the ways through which climate change can be controlled or minimised.

3. Problems to be Investigated

A lot of problems in the Jharkhand can be seen related to weather and climate. But the main problems to be investigated in this research will be dedicated to changing natural landscapes in urban areas and its periphery and the changes that are seen in the weather and climate of that area. Another major problem to be investigated is climate change and the role of land use and land cover in modifying weather and climate of that area. The main problems to be investigated in this research are as under:

- Factors responsible for creation of different micro climatic zones in Jharkhand.
- Increase in build-up area has affected weather of Jharkhand at micro level.
- Decline in vegetation cover and water bodies and its effect upon weather and climate.
- How is the weather been modified in Jharkhand in comparison to past.
- How can Urban Heat Island effect be reduced in the region.
- Reason for sudden rainfall and change in weather in Jharkhand.
- Impact of changing land use and land cover on weather and climate.
- How is the climate change pattern in comparison to the nation and world in Jharkhand.

4. Objectives of the investigation and motivation

i. To identify micro climatic zones of Jharkhand at present and Land Use Land Cover (LULC) changes in the area since 1980s. And the role played by LULC in determining micro climatic variations in different time period.
ii. To determine decadal change in temperature, precipitation, and Urban Heat Island (UHI) since 1980s.
iii. To identify and explain factors responsible for changes in temperature and precipitation at micro level in Jharkhand.
iv. To determine pattern of global climatic change of the world in comparison to Jharkhand.
v. To determine future prospects of Climate Change in Jharkhand and develop ways to minimise Climate change in the region and suggest policy measures.

Many authors and writers have mentioned that Ranchi and parts of Jharkhand had all time good and pleasant climate during 1980s. Many elderly people of Jharkhand have mentioned that Ranchi and the adjoining areas had cool climate throughout the year, summer was not very hot,

so this motivated me for this research. Apart from this the changing climate and global warming is affecting every part of the earth, and this is one of the major concerns for every nation, economists, planners, and even in the national and international conferences. So, this motivated to opt for the proposed research.

5. Research Question

i. What are the different micro climatic zones and the variations within them in Jharkhand and establish relation between land use land cover and climatic variation?
ii. How has climate changed in Jharkhand in terms of temperature, precipitation, and urban heat island since 1980s?
iii. What are the factors responsible for climate change at micro level Jharkhand and variations in temperature and precipitation?
iv. What is the pattern of climate change of Jharkhand in comparison to global climate change pattern?
v. What are the future prospects of climate change in the region? What policy measures can be taken to minimise the adverse effects to climate change at micro level for Jharkhand?

6. Research Design and Methodology

The study area for the proposed research is Jharkhand state of India. Jharkhand is located approximately between 21°57' N and 25°14' N and 83° 20' E and 87°58' E, with total area of 79,714 sq. kms. The area is very well connected to the different states and has seen a rapid change in the buildup area and these changes are unchecked leading to unplanned urbanisation and urban sprawl and changes in land use land cover over the whole Jharkhand over recent years and which is greatly impacting weather and climate, with Urban heat island effect felt in urban areas and thermal severity felt all over the region throughout the year except winters in recent years.

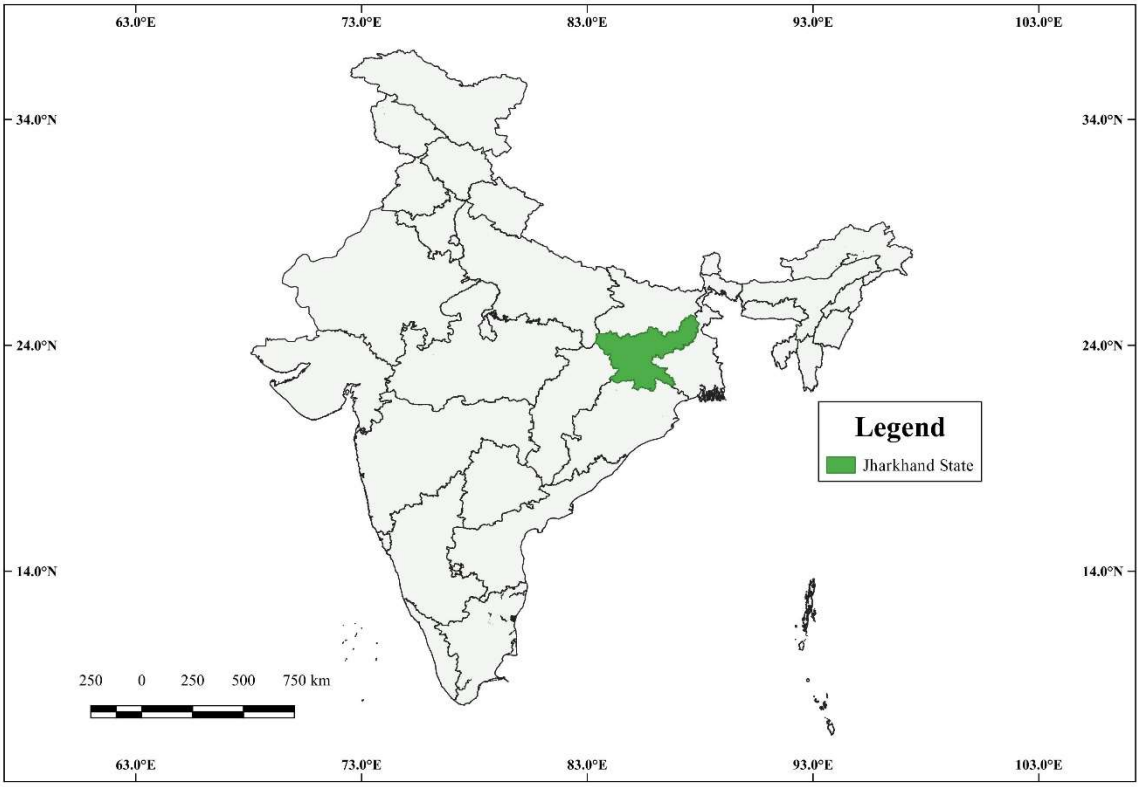
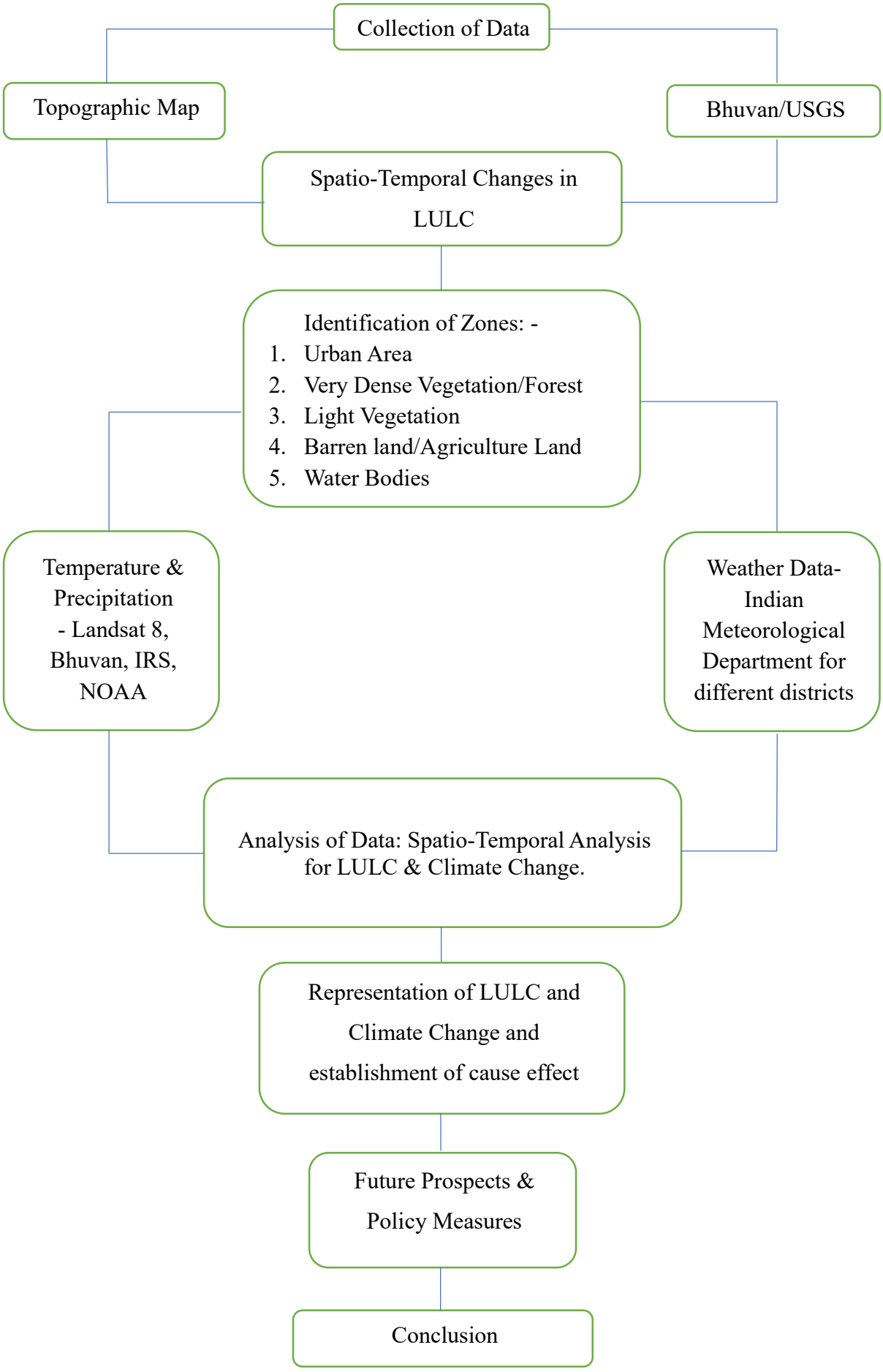


Fig. 1 – Study Area

The data sources for the proposed research will be based on secondary data sources of various climatic data centres like Indian Meteorological Department, World Climate, National Climate Data Centre, National Oceanic and Atmospheric Administration to gain more understanding. Both Qualitative and Quantitative Methods will be used as the research will deal with a number of climatic data since 1980s and many statical methods will be used for the study. as for qualitative method, various Raster and Vector files will be used with the help of software for analysis of the study and the images will be used to represent data and its interpretation will be done. For the analysis of data, Land Use Land Cover will be calculated as to identify major types of land cover found in Jharkhand. Climate data based on temperature and precipitation will be main areas for studying variations in each zone of different Land Use land Cover over time. After this microclimate zones will be identified and variations or differences in each zone will be studied. Spatio-Temporal Analysis of land use land cover and climate data mostly temperature and precipitation for a time period of 35-40 years will be analysed as to establish relationship between the changing land use land cover and the climate change over the zones in the region.


Collection of Data
Topographic Map
Bhuvan/USGS
Spatio-Temporal Changes in LULC
Identification of Zones: -
1. Urban Area
2. Very Dense Vegetation/Forest
3. Light Vegetation
4. Barren land/Agriculture Land
5. Water Bodies
Temperature & Precipitation - Landsat 8, Bhuvan, IRS, NOAA
Weather Data- Indian Meteorological Department for different districts
Analysis of Data: Spatio-Temporal Analysis for LULC & Climate Change.
Representation of LULC and Climate Change and establishment of cause effect
Future Prospects & Policy Measures
Conclusion

Tentative Chapterisation

Introduction

1. Geographical Profile of the study area.
2. Major micro climatic zones of Jharkhand.
3. Climate of Jharkhand in the Past.
4. Causative Analysis: Driving factors for micro climatic zones and variations.
5. A comparative study of global climate pattern to Jharkhand.
6. Spatio-Temporal Analysis of weather in Jharkhand.
7. Suggestive policy measures.

Findings and Conclusions.

8. Sources of data and tools to be used in the collection of data

For the study of the proposed research, secondary data sources will be used. Comparative Study of LULC and climate change of last 35-40 years will be studies on decadal basis. Below are the ways through which data will be collected: -

	Variables	Sources	Data Type
Land Use Land Cover	NDVI (Vegetation) NDWI (Water) SAVI (Soil)	Landsat 8, USGS, Bhuvan-IRS, Sentinal-2	Secondary Sources
	NDBI (Build up) BI (Bareness)	Topographic Map	Secondary Sources
Weather & Climate	LST (Temperature)	IMD, Bhuvan, LiDAR, Landsat 8 USGS, NOAA.	Secondary Sources
	Precipitation	IMD, USGS, NOAA	Secondary Sources

	Air Quality Index	CPCB, IMD, USGS	Secondary Sources
	Radiation Index	LiDAR, Landsat 8 USGS	Secondary Sources
	Urban Heat Island & Heat Waves	Landsat 8 USGS, IMD	Secondary Sources

9. Analysis of data

For the study of Land Use Land Cover (LULC), ESRI ARCGIS, ERDAS and QGIS software will be used. Topographical and satellite data will be used for studying the LULC and climate change of past 35-40 years and for present LULC software will be used to study changes with the help of Thematic Maps, diagrams, and charts. A comparative study of different micro zones with the Jharkhand will be studied based on temperature and precipitation as the primary climatic variable. A comparative study of world climate change pattern will be analysed with the study area to identify future problems, changes, and the measures. Tables, histograms, graphs, charts, and maps will also be used to analyse the weather data and atmospheric conditions and will help in predicting future weather conditions. Correlation will be used to check the relation among different variables of different zones. A comparative study of most sustainable cities will be taken and analysed as to what fields to be taken care of, for attaining a clean and pleasant weather. The data from IMD will be taken into consideration and phenomena of temperature, precipitation, air quality and heat waves will be studied. On the other hand, data from USGS, Landsat TM, Bhuvan and Sentinel I will be taken, and different bandwidth will be taken for studying Land surface Temperature (LST), Normalised Difference Water Index (NDWI), Normalised Difference Vegetation Index (NDVI), Urban Thermal Filed Variance Index (UTFVI) etc. For LULC maps of different time period would be compared and will also be used to study changes in the landscapes. Then, a comparative study of IMD and USGS will be done along with the primary collected ground survey data. And all the data will be studied by ERDAS, ARCGIS and other geographical information tools. A Spatio-temporal analysis of LULC and weather and correlation will be done.

10.Significance of the study

One of the major news globally seen or heard are climate change and the arising natural disasters arising in different parts of the world and number of people affected and loss of life and property and damages to flora and fauna. India being one of the rapidly developing nations in the world with an economy competing to the world's most developed nations and having one of the world's largest populations, contributes largely to Climate change and every part of the country is affected by global warming and climate change but due to having tropical type of climate, impact of climate change caused by the change in land use land cover and urban heat island are not much noticed. Apart from this Jharkhand being a newly formed state, not much concern has been taken to study more about the state. And the number of research in field of climatology specially Jharkhand as study area is limited. So, the proposed research, 'Microclimate study of Jharkhand' will contribute largely to the field of climatology of Jharkhand, as there is very few research conducted recently. Thus, the study will demarcate the recent developments in the field of climate changes in the South Chotanagpur Region and help in develop and implementation of plans, policies, and models for the future.

11.Its relevance to the present-day problem and need to the society.

At present the state is facing drastic changes in land use and land cover, with the natural landforms being modified and development of buildup area everywhere. With these changes the consequence that the state is facing is increase in urban sprawl and development of urban heat island, thermal severity, and drought as some major impacts of climate change. These climate changes are result of change in the natural landscapes. The research will formulate the relation between different land use and their impact in the region and the importance of development of specific types of land use land cover for decreasing the effect to urban heat island and thermal severity. The research will also focus on the urban centres as these are some of the most affected areas by climate change. The research will also formulate models for minimising the impact of climate change.

12.Contribution to the existing knowledge

As we all know that Jharkhand is quite a new state in comparison to other states of India. And the state is one of the underdeveloped states of the country in many fields, due to which very

few are interested in researching and studying about Jharkhand. And the data or knowledge available about Jharkhand is with mergence with Bihar. So, the regional knowledge about various fields of the state is unexplored. This research will try to explore the regional Spatio temporal attributes of the state. The study will contribute to climate changes in the state and help in monitoring the most severely impacted areas to be taken care of. The study will also help in development of climate zones and types in a specific region based on Spatio temporal data. The research will also contribute to studying the land use changes and its impact on the weather and climate of the state. It will also contribute to formulation of agro climate zones of the study area, with identification of detailed climate zones.

13.Future works

The research will solely focus on the Jharkhand as its study area, so one of the major limitations of this research is that it cannot study different parts of country but only a part of it. So, the future works for this field will be to study the Microclimate of different states can be done. Secondly, the study will focus on the Land use land cover and its impact on weather and climate, other attributes like different particles and its impact on climate will not be studied in detail as the scope of the research will become very vast, but the research will only study a small fraction of air quality and its effect on local weather. So, a detailed study of air quality, particles and its impact will be an area for future studies. Another limitation to this research is the microclimate of particular urban area in detail, as there lies a set of different climatic zones within the urban centres but this research will focus urban centres as a single unit of changed landform and its impact and climate change. So, the microclimate study of particular urban centre will be one of the future works to study for.

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